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MODELLING OF PV-BESS AC MICRO-GRID INTEGRATED SYSTEM

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ABSTRACT—

The current power system is shifting from being based on alternators to being dominated by inverters. If the right inverter control technique is applied, grid-tied micro-grids can function effectively while preserving respectable performance at the Point of Common Coupling (PCC). The main goal of this study is to evaluate and contrast the DQ and synchronverter inverter control methods. The mathematical modelling of these control techniques is described. The Sine Pulse Width Modulation (SPWM) technique is used to regulate the gate pulse of a voltage source inverter (VSI). The effectiveness of both control strategies under dynamic conditions, such as variations in the reference active (Pref) and reactive (Qref) powers, is investigated in this work.

Keywords— Photo Voltaic (PV) System, MPPT, T-Type Inverter, Pulse Width Modulation (PWM).

INTRODUCTION :

The growing demand for power has led to a surge in the use of alternative green energy sources. As an alternative power source, photovoltaic (PV) power generation is one of the most promising renewable green energy technologies. In order to integrate PV to the load and enhance performance, power electronic converter aid is required. Because power electronics converters are used in so many independent and grid-based systems, they are become more complicated.

Reducing the environmental and climate change issues caused by conventional power generation is made possible by the use of renewable energy sources. Renewable power generation also serves other goals, such as dependability, affordability, and accessibility to electricity.

Because of their widespread availability and emission-free conversion, wind and solar energy resources are two of the numerous renewable energy sources currently in use. Other advantages of solar energy include more consistent output, a modular space required, noiseless operation, and no maintenance. Electricity is the most often used energy source and is a major component of modern civilisation. However, conventional producing systems have a large negative influence on the environment and produce a great deal of pollution, especially thermoelectric power plants that burn fossil fuels or radioactive materials. Furthermore, fossil fuel prices are rising as a result of declining fossil fuel reserves. In this case, the use of alternative energy sources is growing in popularity for reasons other than reducing pollution in the environment.

Thanks to recent technological breakthroughs, renewable energy options are becoming commercially feasible alternatives. Renewable energy sources fall into the following categories: geothermal, biomass, wind, hydro, solar, and ocean. The electricity from these sources must be captured by highly efficient converters. The DC voltage generated by solar photovoltaic cells must be converted into AC voltage using an inverter, a kind of DC to AC converter, in order to convert solar energy into electrical energy. This is comparable to the conversion of wind energy using a highly efficient induction generator. Renewable energy systems typically lack a regular and dependable energy source. Solar photovoltaic (PV) systems may experience substantial variations in sun irradiation throughout the day.

Consequently, most solar PV installations are grid-connected [1]–[4]. Therefore, a strong grid interface is required to feed the grid without any irregularities. In solar PV cells, DC voltage is generated. DC electric energy is transformed into AC electric energy using an inverter. Maximising energy capture and transferring it to the utility grid is the control objective on the DC side.

The system payback is driven by the energy that the system captures. A more productive system can pay for itself faster, so increasing energy capture can have a significant positive impact [5]–[7].

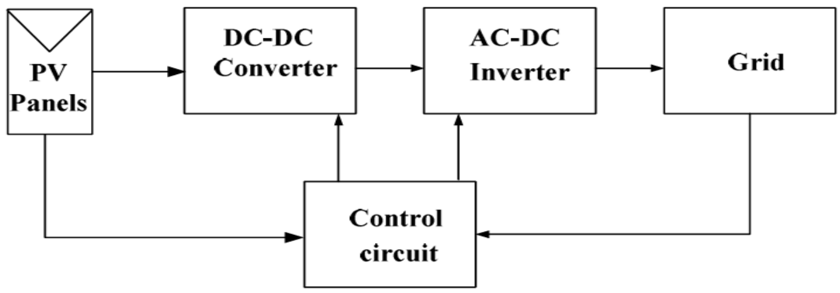

Fig.1. Block diagram of typical grid connected PV systems

STANDARD FOR GRID CONNECTED PV SYSTEM

Providing sinusoidal current to the grid is the primary function of the inverter; in order to increase system dependability, the inverter's connection to the grid and PV panels must comply with PV system criteria. the government's requirements for PV converter performance and installation regulations.

Table-1 Standard for inverters

Parameters	IEC 61727
THD	< 5%
Power factor	0.90
DC current injection	Less than 1% of rated output current
Voltage range for normal operation	85% - 110%
Frequency range for normal operation	49Hz to 51Hz

Different types of topologies

Grid Connected String Inverter

The string inverter topology somewhat offsets the drawbacks of the central inverter technology. As seen in the illustration, the string inverter system uses a string of panels connected in series to provide the grid with AC power. The inverter to which the single string is connected has a maximum power rating of 5kW. Because each string has its own MPPT, maximum power point operation is more accurate than with a centralised inverter system.

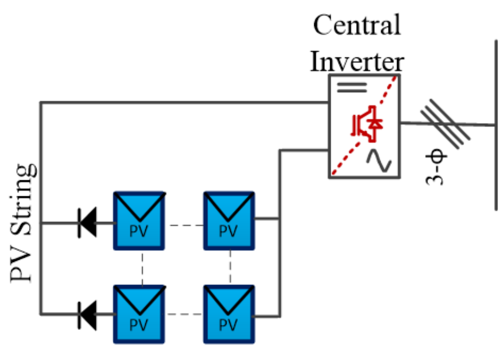

Fig. 5. Single-string inverter technology

Multi String Inverter Topology:

Comparing the multi-string inverter topology to a central inverter system, the power scale (level) has been raised while preserving the benefits of string inverters. A three-phase grid can create and capture high-rated three-phase power. The multi-string system consists of low power DC-DC converters with individual MPPTs in each string that send electricity to the grid and are connected to the inverter via a shared DC bus. PV strings with the same rating and DC-DC converter can be added to the multi-string inverter system by connecting them to the same inverter via a common DC bus. Each of the three strings of PV panels in this setup has a DC DC boost converter.

The same DC bus is linked to both of these DC-DC converters. A complete bridge inverter is connected to three PV strings via a shared DC bus and a DC-DC boost converter. Power flows from PV panels into the utility grid thanks to this DC-DC converter, which separately extracts the maximum power point of each string and increases the inverter's output voltage to synchronise with the grid voltage. Modules, AC cells, and multi-string systems that blend conventional and contemporary technologies are examples of these structures.

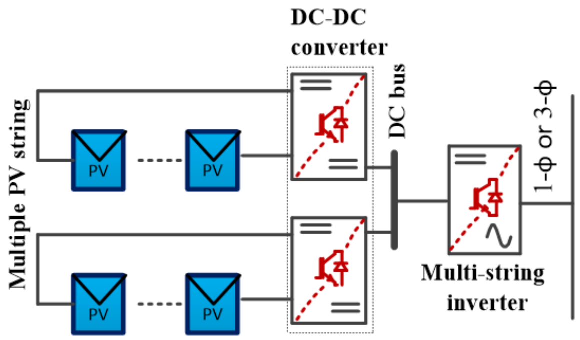

Fig. 5. Multi-string inverter technology

ii Cascaded multilevel inverter for string topology:

The industry's most utilized and popular multilevel topologies are the cascade H-bridge (CHB) MLI and the 3L-NPC-MLI. It is imperative to observe that 7L to 17L-CHB-MLI possess a complicated circuit structure and 3L-Neutral-Point-Clamped (NPC) MLI possess poor quality of power. Therefore, it would only be unfair to compare these two commercially availablemultilevel inverters.

Number of cells are connected in series with isolated DC link for each cell to make cascade connection and each cell produces three levels of voltage i.e.,$V_{dc}/2$,0,-$V_{dc}/2$.

For "n" cell number of output voltage levels will be (2n+1). For"n" cell total output voltage is given as,

$V_{an} = V_{H1} + V_{H2} + V_{H3} + \ldots\ldots\ldots\ldots + V_{Hn}$

Fig.3.11 shows 5-level cascaded H-bridge inverter with 2 cells connected in series, provides $2V_{dc}/2$, $V_{dc}/2$, 0, $-V_{dc}/2$, $-2V_{dc}/2$ five level of output voltage

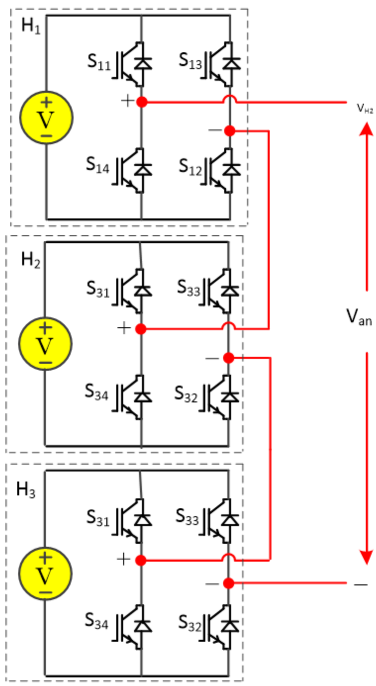

Fig:6 Cascaded multilevel inverter for string topology

Grid Connected Micro-Inverters:

Microinverter topology refers to the development of inverter architectural topologies to reduce the losses and drawbacks of string and centralised inverter systems. Because the microinverter topology is a module integrated inverter, as shown in Figure 8, electricity is transmitted directly to the grid through the small, low-rated inverter with its own MPPT in each module. Microinverter systems' main advantage is its ability to lessen or completely eliminate the effects of shadowing and clouding in PV systems. The performance of the other modules in this design is unaffected if partial shading is applied to just one module.

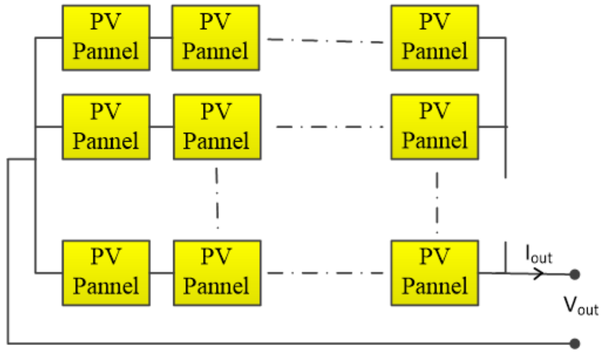

Fig:7 series parallel array configuration.

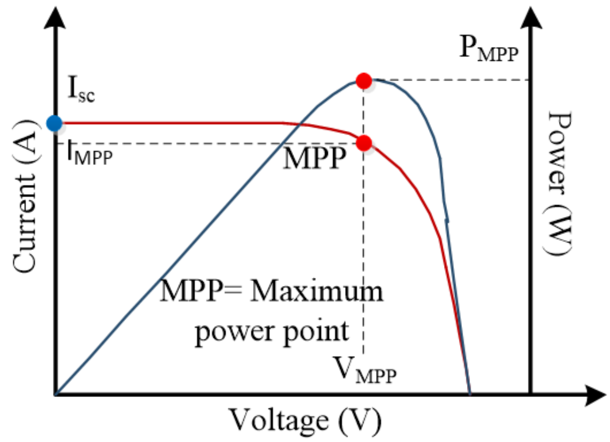

Fig.8 I-V and P-V characteristics of a PV cell

The point on a current voltage (I-V) curve where the solar PV device produces the most output, or where the product of current intensity (I) and voltage (V) is maximal, is known as the maximum power point (MPP). External variables like temperature, light levels, and device performance might affect the MPP.

Numerous methods for tracking maximum power points have been put forth, examined, and put into practice. By altering the duty ratio, D, of the dc-dc converter by a factor AJ, the current extracted from the PV array is periodically perturbed using the perturb and observation (P&O) method. The output power that results is then compared to that of the preceding perturbation cycle.

If a greater duty ratio ($D + \Delta D$) yields a higher power, it is increased further until the output power starts to drop. Conversely, if a higher duty ratio leads to less power than previously, the duty ratio is lowered until power output starts to decline instead of rising. A microprocessor, microcontroller, or digital signal processor is used to multiply the output voltage and current in order to calculate the PV array's output power.

The P&O method is quite accurate as it tracks the true MPP.

CONCLUSION :

This work investigates the performance of a 3-grid connected VSI and does simulations for DQ control and synchronverter controller using the same settings. Synchroverter control is developed through mathematical modelling of synchronous machines, and DQ-control is derived using the decoupling technique and synchronous reference frame dynamic equations. When it comes to dynamic performance, synchronverter control changes instantly whenever the Pref and Qref are changed in DQ-control.

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